CLAIMS

What is claimed is:

1. A system for identifying defects and foreign objects and debris during fabrication of a composite structure, the system comprising:

at least one light source positioned to emit light for illuminating a portion of the composite structure with bright field illumination and another portion of the composite structure with dark field illumination, the bright field illumination being reflected differently by defects in the composite structure than from portions of the composite structure that are defect free, the dark field illumination being reflected differently by foreign objects and debris on the composition structure than from surfaces of the composite structure not having foreign objects and debris thereon; and

at least one camera for receiving images of the illuminated portions of the composite structure.

2. The system of claim 1, further comprising a processor for processing the images and outputting a response identifying defects and foreign objects and debris based on the images.

3. The system of claim 2, further comprising an interface for allowing at least one user input for the processor.

4. The system of claim 3, wherein:

the processor is capable of binarizing images by setting all pixels representing a color darker than a predetermined gray level to one of black or white and setting all other pixels to the other of black or white; and

the user interface allows a user to set a threshold representative of the predetermined gray level utilized by the processor to binarize the images.

5. The system of claim 1, further comprising a memory device for storing the images.

6. The system of claim 1, wherein the light source is moveable relative to the composite structure.

7. The system of claim 1, wherein the at least one light source comprises a plurality of light sources located at different respective positions relative to the composite structure.

8. The system of claim 1, wherein the at least one light source comprises a plurality of light sources coupled to a switching device for selectively activating and deactivating the light sources.

9. The system of claim 8, wherein the switching device comprises a user interface.

10. The system of claim 1, wherein:

the camera is moveable relative to the composite structure; and

the camera receives real-time images of the illuminated portions of the composite structure as the camera moves relative to the composite structure.

11. The system of claim 1, wherein the camera and the light source are mounted on a head unit of a fiber placement machine.

12. The system of claim 11, wherein the camera receives real-time images of the illuminated portions of the composite structure as the head unit moves across the composite structure.

13. The system of claim 1, wherein the camera and the light source are proximate a compaction roller of a fiber placement machine.

14. The system of claim 1, wherein the at least one camera comprises:

a first camera for receiving images of the portion of the composite structure being illuminated by bright field illumination; and

a second camera for receiving images of the portion of the composite structure being illuminated by dark field illumination.

15. The system of claim 1, further comprising at least one reflective surface proximate the composite structure such that the camera receives the images of the illuminated portions following reflection of the images from the reflective surface.

16. The system of claim 15, wherein the reflective surface and the light source are mounted on a head unit of a fiber placement machine.

17. The system of claim 15, wherein the reflective surface and the light source are proximate a compaction roller of a fiber placement machine.

18. The system of claim 1, wherein the camera comprises at least one of:

an infrared-sensitive camera; and

a visible light camera with infrared-pass filtration.

19. The system of claim 1, further comprising a filter for preventing substantially all ambient visible light from entering the camera.

20. The system of claim 1, wherein the camera is capable of distinguishing light from the light source and ambient visible light.

21. The system of claim 1, further comprising a light reflection element proximate the light source to redirect light from the light source towards the composite structure.

22. The system of claim 21, wherein the light reflection element comprises a plurality of reflective parabolic curved surfaces in a stepped configuration.

23. The system of claim 1, wherein the light source includes an infrared component.

24. The system of claim 1, wherein the light source comprises at least one of:

an incandescent light;

a light emitting diode;

a noble gas arc lamp;

a metal arc lamp;

a strobe;

a fluorescent light; and

a laser.

25. The system of claim 1, wherein:

the composite structure includes plurality of adjacent composite strips positioned in a common direction; and

the light source is positioned to emit light in a direction substantially perpendicular to the common direction of the composite strips.

26. The system of claim 1, further comprising a marking device for marking the defects and foreign objects and debris identified by the system.

27. The system of claim 26, wherein the marking device comprises at least one of an inkjet sprayer and a pump-fed felt-tip marker.

28. A system for identifying foreign objects and debris on a composite structure during fabrication thereof, the system comprising:

at least one light source positioned to emit light for illuminating at least a portion of the composite structure with dark field illumination, the dark field illumination being reflected differently by foreign objects and debris on the composition structure than from surfaces of the composite structure not having foreign objects and debris thereon; and

at least one camera for receiving images of the illuminated portion of the composite structure.

29. The system of claim 28, wherein the light from the light source illuminates another portion of the composite structure with bright field illumination, the bright field illumination being reflected differently by defects in the composite structure than from portions of the composite structure that are defect free.

30. The system of claim 28, further comprising a processor for processing the images and outputting a response identifying foreign objects and debris based on the images.

31. A method for identifying defects and foreign objects and debris during fabrication of a composite structure, the method comprising:

illuminating a portion of the composite structure with bright field illumination that is reflected differently by defects in the composite structure than from portions of the composite structure that are defect free;

illuminating another portion of the composite structure with dark field illumination that is reflected differently by foreign objects and debris on the composition structure than from surfaces of the composite structure not having foreign objects and debris thereon;

acquiring an image of the illuminated portions of the composite structure;

analyzing the image to identify defects in the portion of the composite structure illuminated by the bright field illumination; and

analyzing the image to identify foreign objects and debris on the another portion of the composite structure illuminated by the dark field illumination.

32. The method of claim 31, wherein:

analyzing the image to identify defects comprises analyzing image portions representative of reflections of the bright field illumination; and

analyzing the image to identify foreign objects and debris comprises analyzing image portions representative of reflections of the dark field illumination.

33. The method of claim 31, wherein analyzing the image to identify defects comprises converting at least a portion of the image into a dichotomous representation above or below a threshold.

34. The method of claim 31, further comprising marking defects and foreign objects and debris on the composite structure.

35. The method of claim 31, further comprising positioning at least one light source to emit light for illuminating the portion of the composite structure with bright field illumination while also illuminating the another portion of the composite structure with dark field illumination.

36. The method of claim 31, further comprising moving the light source relative to the composite structure to illuminate other portions of the composite structure with bright field illumination and dark field illumination.

37. The method of claim 36, further comprising moving a camera relative to the composite structure to acquire images with the camera of the other illuminated portions.